THE SARCOPHAGINÆ AND THEIR RELATIVES IN NEW YORK, PART I[1]

By Harold C. Hallock
Pennsylvania State College

INTRODUCTION

An attempt is made in this paper to define the limits of a small group of muscoid flies, the *Sarcophaginæ* and their relatives in so far as the species, which occur in New York, are concerned. A study of the structures of the male hypopygium of the *Sarcophaga* has been included in the hope that a better understanding of the relationship of the species to each other might be obtained.

The correct understanding of North American *Sarcophaginæ* must be based upon the work of Dr. J. M. Aldrich. Twenty-two years ago Aldrich (1916) published his "*Sarcophaga* and Allies" which produced an orderly arrangement of the group for the first time. Several years later he had an opportunity to visit the European Museums and study the types of the early authors. As a result of this study Aldrich (1924, 1930) pointed out the synonomy of many names that were in common use in American literature.

Reference must also be made to the important studies by Dr. R. R. Parker which were published in many widely scattered papers from 1914 to 1923. Parker described several new species and made a careful study of the structures of some species of the *Ravinia* and *Boettcheria* groups of the genus *Sarcophaga*. We must also depend upon Parker (1916, 1919) for our understanding of *Sarcofahrtia*.

A discussion of North American *Sarcophaginæ* would not be

[1] As this study was completed while the writer was at Cornell University this article is a contribution from the Department of Entomology, Cornell University, Ithaca, New York. The writer desires to acknowledge assistance from Prof. Robert Matheson, Prof. O. A. Johannsen, Cornell University: Mr. David G. Hall, U. S. National Museum; Dr. Richard Dow, Boston Soc. Nat. History; and Mr. H. G. Reinhard, Texas Agricultural Experiment Station. The writer is also grateful for the valuable assistance of his wife, Mabel M. Hallock, during the proof reading.

complete without reference to Mr. David G. Hall who has published (1926–1937) about a dozen papers dealing with American *Sarcophagidæ*. The most important of his papers are "*Sarcophaga pallinervis* and related species in the Americas" (1928) and "The *Sarcophaginæ* of Panama" (1933).

There are also many taxonomic papers by Dr. C. H. T. Townsend which must be considered for a complete understanding of the New York species. The remaining taxonomic, biological and economic papers, which have been consulted, are widely scattered in the literature. As a result it seems wise to give a summary of this information dealing with New York *Sarcophaginæ* and their relatives.

The tribe, *Miltogrammini,* of the *Sarcophagidæ* will not be considered in this paper as these flies have been very well treated by Allen (1926). Very little new information about the New York *Miltogrammini* has been obtained during the past twelve years. The remaining species of *Sarcophagidæ,* which are known to occur in New York and a few others which are likely to be found in New York, are discussed in this paper. Keys are given to separate the genera of this portion of the family and the species occurring in the different genera. The discussion of the species will deal largely with a few distinctive characters, their distribution in New York and the known hosts or other larval food habits of the *Sarcophaginæ*. The male genitalia will be considered in so far as they tend to aid in the illustration of the group relationships and help in the determination of the species.

The known distribution for each species and the total seasonal occurrence of the adults is given for New York. Credit for the collection of the different species is not repeated, as this information has been given by Leonard (1928) and Hallock (1937).

The writer has found that special methods of preparing the male genitalia for study are necessary. A combination of several of the published methods with some variation has proved most satisfactory. When there is an abundance of material the genitalia of a few specimens of each species are dissected, soaked in potassium hydroxide to remove the soft muscle parts, etc., washed in several changes of water to remove the potash, transferred to cellosolve and then mounted on slides in Canada balsam in such a

manner as not to flatten out the parts. The minute details of the specimen, which cannot be seen plainly with a binocular, may now be examined to advantage with the higher powers of the compound microscope. This method has been used by Patton (1933) and Senior-White (1924) but Hardy (1927) objected to the use of potash. Other specimens should be studied with the genitalia *in situ* as described by Parker (1914) and Aldrich (1916) to correct any errors. The potash may dissolve some of the more delicate parts of the ædeagus or as a result of the dissection and soaking in potash a portion of a sclerite may drop off and be lost. This is very likely to occur in the case of the portion of the sclerite immediately surrounding the lower portion of the V of the fifth sternite.

LIFE HISTORY

The *Sarcophaginæ,* as all other Diptera, are insects with complete metamorphoses. They pass through four stages, egg, larva, pupa and adult during their life cycle.

Egg: Most *Sarcophaga* do not lay eggs but larviposit first instar larvæ, upon the host or larval food. In this case the entire embryological development has taken place within the female fly and the larvæ have hatched before larviposition.

In cases where there is an abundance of meat or other proper food for the larvæ the female fly may oviposit eggs upon the meat. This oviposition was observed by Smith (1933) during his study of *Sarcophaga securifera.* He observed that these eggs either hatched immediately or within the following eight or nine hours.

The writer has dissected female flies of *Sarcophaga bullata, S. latisterna,* and *S. misera* var. *sarracenioides* and found larvæ which had already hatched. Several other species of *Sarcophaga* have been observed to larviposit when upon the point of death in a killing jar.

Larva: Each larva passes through three instars during the development. The first instar is normally very short. Smith (1933) pointed out that the first instar was completed in thirteen to sixteen hours at a temperature of 80° F. He also found that the second molt occurred ten to twenty hours later. The larvæ became completely developed in about six days after deposition and migrated to the soil to pupate.

Under normal temperature conditions Hallock (1929) found that the larvæ of *S. latisterna* developed in four to five days. At the same time the larger species, *S. bullata,* took an average of eleven days to develop. It was also observed that *bullata* developed slower during cool periods in the summer but its development was completed in six to ten days during the hot periods of the summer. This should be contrasted with the slow development of the larvæ of *S. fletcheri* in pitcher plants. Larvæ which had already reached the third instar stage during July, 1936, were observed to feed for a period varying from six to ten days before pupation. This would indicate the possibility that the entire larval stage may last about a month.

PUPA: The sarcophagid pupal period is subject to considerable variation at different seasons of the year. The writer found in early September, 1935, that *S. bullata* pupated but the flies did not emerge when kept at the normal fall temperatures. During the summer months the pupal period lasted normally ten to fourteen days. Smith (1933) found that *S. securifera* remained in the pupal stage from ten to thirteen days when kept at a temperature of 80° F.

ADULT: There is very little information available about the length of life of the adult fly. Smith (1933) reported that the maximum length of life of *S. securifera* was about a month. He also found that oviposition did not take place until eight to fourteen days after emergence. It also appears that meat must be included in the diet of the adult fly in order that larvæ will develop. The writer's experience in rearing *S. bullata, S. sarracenioides* and *S. securifera* agree with Smith's findings that meat is a necessary part of the fly diet in order that larvæ may develop.

The number of generations in any season depends upon the species, availability of suitable larval food, and temperature. *Sarcophaga cimbicis* has been found flying in New York from May until October. It attacks a wide variety of hosts so it should be able to find larval food easily. The larval development is rapid and a cool period, during the summer, does not appear to delay development as much as in the case of some of the species, such as *bullata,* for example. There must be several overlapping genera-

tions although the complete life history of the parasite, *cimbicis*, has not been worked out. This long period of adult abundance may be contrasted with *Sarcophaga aldrichi* which occurs in New York from late May until early July. This species appears to be limited to a few Lepidopterous hosts and *Malacosoma disstria* is the preferred one. Although the life history has not been completely studied, available data points to one generation with a fairly long period of adult emergence. The scavenger groups, including the dung and dead animal feeders, have several overlapping generations.

THE MALE HYPOPYGIAL STRUCTURES

The terminology which has been followed in this study is adapted from Snodgrass (1935). A few terms which seem more descriptive of the structure have been adapted from Patton (1933–1935) after studying his series of papers in the "Annals of Tropical Medicine and Parasitology." A comparison of the terms which have been used by workers on the Sarcophagidæ, is given in Table 1.

A careful study was made of the hypopygium of about 30 species from New York and the internal hypopygial structures are illustrated in this paper (Figs. 1–97). The structure of *Hypopelta scrofa* is described and compared with the variation found in the other species of *Sarcophaginæ*.

The visceral part of the abdomen of *H. scrofa* consists of segments one to five, but the first segment has been obscured by reduction and union with the second. As a result the segments (one to four) mentioned in all systematic papers are segments two to five of the Dipterous abdomen. In order to avoid confusion the systematic system has been adapted in the systematic part of this paper when referring to the first four segments of the abdomen. The references to the hypopygial structure will be made by a name assigned to the part or, when mention is made by segment number; the true abdominal segment number will be used in the case of all hypopygial segments. Segments six to ten and the fifth sternum are included in the hypopygial structures and many of these structures have valuable taxonomic characters.

There has been considerable reduction, obliteration, and modification of the male genitalia structures in *H. scrofa* and the other

Sarcophaginæ so it is difficult to correctly name the structures. The fifth sternum (Fig. 2) is a convex sclerite with a deep U cut in its caudal margin. *Hypopelta scrofa* has two raised projections on the base of the U, which are lacking in the majority of the *Sarcophaginæ*. The U of *H. scrofa* becomes a V in the *Sarcophaga* as illustrated by *S. bullata*. Segment six appears to be obliterated as in the case of *Pollenia rudis* studied by Snodgrass (1935) and segment seven consists of a smaller tergal plate than in the case of *rudis*. The seventh spiracle is present in the membranous walls on the lateral side of the body just cephalad of the eighth segment. The eighth segment has a well developed tergum which has often been mentioned in American taxonomic literature as the first segment of the hypopygium. The sternum of the eighth segment, which helps to support the fifth sternum, is reduced to a narrow sclerotic band, which is incomplete on the right side. The eighth sternum has no taxonomic value and is not illustrated. The tergum of the ninth segment has been called the second segment of the hypopygium in taxonomic literature. The sternum of the ninth segment projects forward and upward from the lower angles of the ninth tergum and forms the dorsal wall of a large pouch which is invaginated within the eighth sternum. The phallic organs normally extend into this pouch. The ninth sternum (Fig. 4) is a broad plate with its posterior angles produced as two arms which embrace the base of the ædeagus. The plate in the case of *H. scrofa* has been reduced and the arms enlarged but *Sarcophaga hæmorrhoidalis* has a normal ninth sternum (Fig. 62). There are two lateral bars which connect the ninth sternum to the tenth segment. The tenth segment has been reduced to a membranous area surrounding the anus. There are two lobes connected with this tenth segment which Snodgrass has termed lateral lobes but in this paper they are called anal forceps (Figs. 1, 3). The term, forceps, has been used by Aldrich and Parker and is very descriptive of the sclerite. The lobes which are attached to the ninth segment and given no definite name by Snodgrass, are called accessory plates (Fig. 1) which is the name used by Parker (1914) and Aldrich (1916).

The phallic organs of *Sarcophaginæ* consist principally of a well developed ædeagus and supporting basal structures. The struc-

ture which has been termed ædeagus by Snodgrass has been called phallosome by Patton, and penis by Aldrich, Parker and several other taxonomic writers. The ædeagus is a large irregular structure (Fig. 1). The sclerites called anterior and posterior claspers (Fig. 1) by taxonomic writers are the lateral processes of the ædeagus. The shape of the claspers has considerable value as a taxonomic character but is less important than the ædeagus. There is a very small sclerite at the base of the claspers which Parker (1914) termed the fulcral plate. This plate, which varies very little in the species studied, has no importance in classification and is not illustrated. The basal apodeme (Fig. 5) is represented by a low thecal fold. The free end of the basal apodeme extends cephalad and the attached end surrounds the base of the ædeagus. The basal apodeme of *H. scrofa* is broader and shorter than the average *Sarcophaginæ* which is illustrated by *Sarcophaga bullata* (Fig. 54), a typical *Sarcophaga* species. The basal apodeme serves for muscle attachment. The sperm pump sclerite (Fig. 6) is situated above the basal apodeme and serves for muscle attachment. The sperm pump sclerite is connected with the ejactulatory bulb, which connects with the ejaculatory duct. Distal to the ejaculatory bulb the duct enters the base of the phallus and thus connects with the ædeagus.

Most of the structures discussed above have been illustrated for the species of *Sarcophaga* which occur commonly in New York. These structures will be discussed further under the genus to show the relationship of the groups.

CLASSIFICATION

The limits of a small group of New York Muscoid flies, the *Sarcophaginæ* and their relatives, will be outlined in the following pages. These flies belong to the order *Diptera* and the family *Sarcophagidæ*.

All the flies in this group have a longitudinal seam along the upper outer edge of the second antennal segment. The arista is generally plumose half its length but in some cases it may be only pubescent or even entirely bare. The mouth parts are well developed and functional. There is a row of strong bristles on the hypopleura. The postscutellum is not distinct and the metanotum

TABLE 1

COMPARISON OF HYPOPYGIAL TERMINOLOGY USED BY WRITERS ON *Sarcophaginæ*

Author	Snodgrass	Patton	Aldrich	Parker
fifth sternum	fifth sternum	fifth sternum	fifth sternum	fifth ventral plate
seventh tergum	seventh tergum	sixth tergum	.....	.....
eighth tergum	eighth tergum	seventh tergum	first segment of hypopygium	first genital segment
eighth sternum	eighth sternum	.....	.....	.....
ninth tergum	ninth tergum	tenth tergum	second segment of hypopygium	second genital segment
ninth sternum	ninth sternum	ninth tergosternum	.....	genital sternum
anal forceps	lateral lobes	anal cerci	forceps	forceps
accessory plate	lobes	ninth coxites	accessory plate	accessory plate
ædeagus	ædeagus	phallosome	penis	penis
anterior clasper	.....	anterior part of paramere	anterior clasper	anterior clasper
posterior clasper	.....	posterior part of paramere	posterior clasper	posterior clasper
fulcral plate	.....	.....	.....	fulcral plate
basal apodeme	basal apodeme	apodeme of phallobase	.....	.....
pump sclerite	central apodeme	sperm pump sclerite	.....	.....

has only a single convexity. There are three or four notopleural bristles present. The species found in this group are generally grayish with a more or less tessellated abdomen and three to five longitudinal stripes on the thorax.

The *Calliphoridæ* are considered as a distinct family at the present time. When the world fauna has been completely studied it may be found necessary to unite the *Sarcophagidæ* with the *Calliphoridæ*. As there are always border line forms which can be placed only with difficulty the *Sarcophagidæ* will be considered here as a separate family.

In this study the tribe *Miltogrammini,* of the *Sarcophagidæ* will not be discussed. This tribe includes species with the accessory plate as long or longer than the anal forceps. The impression of the bucca, near the vibrissal angle, is small and not deeply submerged beneath the parafacials and remainder of the bucca. The sternopleuron never has more than two bristles and the segments of the abdomen lacks discal bristles.

The group studied in this paper is divided into twelve genera. In order to make identification as simple as possible all the species in the several genera are included in the same key (which will be given in Part II), although keys to the species are given for the individual genera in some cases.

KEY TO GENERA

1. Arista long plumose 2
   Arista short plumose 5
   Arista bare or only short pubescent 7
2. First, third and fifth veins with a row of bristles..... *Johnsonia* Coquillett
   The fifth vein always bare 3
3. Fourth vein ending at the tip of the wing..... *Opsodexia* Townsend
   Fourth vein ending far before the tip of the wing..... 4
4. Front strongly produced, antennal axis strikingly greater than the vibrissal and frontal profile sloped; the caudal end of male abdomen appearing truncate ..... *Metoposarcophaga* Townsend
   Front normal; abdomen not truncate in appearance..... *Sarcophaga* Meigen
5. Fourth vein ending at the tip of the wing..... *Opelousia* Townsend
   Fourth vein ending far before the tip of wing..... 6
6. Some pale hairs on back of head; epaulets black..... *Hypopelta* Aldrich
   Only black hairs on back of head; epaulets light colored.
   Sarcofahrtia Parker
7. Median marginal bristles present on first abdominal segment; frontal bristles not descending below base of antennæ; ovipositor of female drawn out like an awl..... *Macronichia* Rondani

Median marginal bristles absent on first abdominal segment; frontal bristles extend below base of antennæ 8

8. Abdomen with three rows of shining spots on the second, third, and fourth segments; these are sometimes confluent; fifth sternite entire ..... *Wohlfahrtia* B. & B.

Abdomen pollinose, at most the hind part of segments shining black in certain lights 9

9. Parafacials without bristles; antennæ yellow ..... *Erythrandra* B. & B.

Parafacials with a row of bristles; antennæ black 10

10. Second abdominal segment with median marginal bristles; anterior acrostichals present; scutellum with a pair of apical bristles. *Oppiopsis* Townsend

Second abdominal segment without median marginal bristles; anterior acrostichals lacking; apical bristles lacking on scutellum. *Laccoprosopa* Townsend

DISCUSSION OF GENERA AND SPECIES

Macronichia Rondani

1859. Rondani, Dipt. Ital. Prod., vol. 3, p. 229.

1931. Townsend, Ann. and Mag. of Nat. Hist., vol. 8, p. 379.

Townsend (1931) pointed out that the *Amobia* of authors is *Macronichia* Rondani. As a result our New York species, *aurata* and *confundens,* fall in the genus, *Macronichia.*

Genotype.—*Macronichia ungulans* (Pand.).

Macronichia aurata Coq.

1902. Coquillett, Proc. U. S. N. M., vol. 25, p. 119.

The two species of *Macronichia* found in New York are easily separated as *aurata* has the fourth abdominal segment and remainder of abdomen posterior to it golden yellow pruinose. The fourth abdominal segment is crossed longitudinally by brownish spots.

Length.—7 to 8 mm.

Records.—Owego; Ithaca; Tuxedo. Last of June through August.

Type.—Cat. No. 6233, U. S. N. M.

Macronichia confundens Town.

1915. Townsend (*Amobiopsis confundens*), Proc. Biol. Soc. Wash., vol. 28, p. 20.

The gray pollinose thorax of this species is marked by three to

five black vittæ. The abdomen is gray pollinose, marked with three rows of black spots on the dorsum of the four abdominal segments.

Length.—7 to 9 mm.

Records.—Tuxedo. July 24–28.

Type.—Cat. No. 19134, U. S. N. M.

Opelousia Townsend

1919. Townsend, Proc. U. S. N. M., vol. 56, p. 547.

There is very little known about the habits of the *Opelousia*. Townsend (1935) recorded that *Opelousia* have been reared from snails.

Genotype.—*Opelousia obscura* Townsend.

Opelousia obscura Townsend

1919. Townsend, Proc. U. S. N. M., vol. 56, p. 547.

This species was originally described from three males taken in Louisiana and one male from North Dakota. The species is moderately common in the south. The writer has seen four specimens taken near Atlantic City, New Jersey. As the species has a fairly wide range of distribution it may be expected to occur in New York.

Length.—4 to 4.5 mm.

This fly was recorded by Reinhard (1929) as a parasite of the snail, *Succinea luteola*. The parasite passed the winter in the pupal stage within the shell of its host.

Type.—Male, No. 22249, U. S. N. M.

Opsodexia Townsend

1915. Townsend, Proc. Biol. Soc. Wash., vol. 28, p. 20.

The host relations of this group are unknown. Townsend (1935) described the female reproductive organs for *Opsodexia* and pointed out that the fecundity was very small, "at most a dozen at a deposition." The adult flies have been recorded on *Solidago, Baccharis* and other *Compositæ*.

Genotype.—*Opsodexia bicolor* (Coq.).

Opsodexia bicolor Coquillett

1899. Coquillett, Jour. N. Y. Ent. Soc., vol. 7, p. 221.

1915. Townsend, Proc. Biol. Soc. Wash., vol. 28, p. 20.
1935. Townsend, Manual of Myiology, Pt. 2, p. 256.

The legs are largely yellow and in the light form the abdomen is yellow except a dark line along the apex of each segment. The dark form has the femora largely black and the abdomen mostly dark with gray pollinose.

Length.—5 to 6 mm.

Records.—Ithaca; Hancock; Millwood; Corinth; Lake George; Kaaterskill; *L.I.*: Cold Spring Harbor; Wading River; Babylon. June to September.

Type.—Cat. No. 4121, U. S. N. M.

Opsodexia abdominalis Reinhard

1929. Reinhard, Proc. U. S. N. M., vol. 76, art. 20.

The type locality of *Opsodexia abdominalis* is Fabyans, N. H., so the species can be expected to occur in northern New York. The fly was taken on flowers of *Solidago*.

This species may be readily separated from *O. bicolor* by the black densely gray pollinose abdomen. It differs further in that the fourth vein is broadly bowed and lacks a definite angle, and the arista has shorter hairs and is practically bare beneath.

Length.—7 mm.

Type.—Male. Cat. No. 41986, U. S. N. M.

Laccoprosopa Townsend

1891. Townsend, Trans. Am. Ent. Soc., vol. 18, p. 366.
1935. Townsend, Man Myiol., Part II, p. 180.

Curran (1934) placed the species found in this genus in the Brachycoma although in the New York State List, 1928, he used the name *Laccoprosopa avium* Curran for a manuscript species. It seems best at this time to retain the genus *Laccoprosopa*.

Genotype.—*Laccoprosopa sarcophagina* Townsend

Laccoprosopa sarcophagina Townsend

1891. Townsend, Trans. Am. Ent. Soc., vol. 18, p. 366.

The genus *Laccoprosopa* is represented by a single species in New York. Leonard (1928) recorded this species in New York as *L. avium* Curr. (manuscript name). Mr. David G. Hall, U. S.

National Museum, has kindly studied the specimens and determined them to be *Laccoprosopa sarcophagina* Townsend. The specimens also were compared with a homotype (determined by Dr. J. M. Aldrich) in the U. S. National Museum.

Length.—7 to 8 mm.

Records.—Ithaca. Five adults reared from larvæ parasitic on young crows. "Ithaca, N. Y., Cornell University, Exp. No. 1023, sub. 272 (I. Dobroscky)."

Plath (1922, 1934), Frison (1926) and Townsend (1936) recorded *L. sarcophagina* as heavily parasitising five species of bumblebees (*Bombus auricomus, B. feroidus, B. americanorum, B. bimaculatus,* and *B. vagans*).

Oppiopsis Townsend

1915. Townsend, Proc. Biol. Soc. Wash., vol. 28, p. 20.
1916. Aldrich (*Harbeckia*), *Sarcophaga* and Allies, p. 47.
1918. Townsend, Proc. Ent. Soc. Wash., vol. 20, p. 20.

The genus was erected by Townsend (1915) and in 1918 he pointed out that *Harbeckia* Aldrich was synonymous. A single species *Oppiopsis sheldoni* has been taken on Long Island.

Genotype.—*Oppiopsis sheldoni* (Coq.).

Oppiopsis sheldoni Coq.

1898. Coquillett (*Brachycoma sheldoni*), Can. Ent., vol. 30, p. 233.
1915. Townsend (*Oppiopsis sheldoni* Coq.), Proc. Biol. Soc. Wash., vol. 28, p. 20.
1916. Aldrich (*Harbeckia tesselata*), *Sarcophaga* and Allies, p. 47.
1918. Townsend, Proc. Ent. Soc. Wash., vol. 20, p. 20.

Specimens of *O. sheldoni* have been recorded from many localities throughout the northeastern part of the United States but the species does not appear to be numerous at any one time.

Length.—6 to 8½ mm.

Record.—Babylon, July 15.

Type.—Cat. No. 4069, U. S. N. M.

Erythrandra B. & B.

1891. Brauer and Bergenstamm, Denkschr. Kais. Akad. Wiss. Wien, vol. 58, p. 368.

1897. Coquillett (*Brachycoma*), U. S. D. A. Tech. Ser. No. 7, p. 131.
1916. Townsend (*Eubrachycoma*), Ins. Ins. Men., vol. 4, p. 19.
1924. Aldrich (*Erythrandra* B. & B.), Ann. Ent. Soc. Am., vol. 17, p. 211.

Aldrich studied the type from the Vienna Natural History Museum and pointed out in 1924 that our American species which Coquillett (1897) described as *Brachycoma apicalis* belonged in the genus *Erythrandra* B. & B. This genus is represented by a single species in New York.

Genotype.—*Erythrandra picipes* B. & B.

Erythrandra picipes B. & B.

1891. Brauer & Bergensta, Denkschr. Kais. Akad. Wiss. Wien, vol. 58, p. 368.

The synonymy of this species is discussed by Aldrich (1924) in detail. Townsend (1935) states that *Eubrachycoma apicalis* C. is distinct from *Erythrandra picipes* B. & B. on the ground that *Eubrachycoma apicalis* has the third longitudinal vein bristled at least half way to first cross vein while *Erythrandra picipes* has the third longitudinal vein bristled only at the base. The specimen of *E. picipes* (det. by Aldrich) which the writer has examined from New York has the third longitudinal vein bristled only at the base.

Length.—7 mm.

Records.—Black Mt., Lake George. September.

Type.—Vienna Natural History Museum.

Johnsonia Coquillett

1895. Coquillett, Proc. Acad. Nat. Sci., vol. 47, p. 316.

Hall (1933) pointed out that the diagnostic characters of this homogeneous genus were the setulose fifth vein and the long bristles on the cheeks.

Genotype.—*Johnsonia elegans* Coq.

Johnsonia borealis Reinhard

1937. Reinhard, Bull. Brooklyn Ent. Soc., vol. 32, p. 62.

Reinhard (1937) described *Johnsonia borealis* from two female specimens which were taken in Ohio and Michigan. As the spe-

cies of this genus are nearly all southern in their distribution this was the first species of *Johnsonia* known to occur in northeastern United States. Hallock (1938) described the male of *Johnsonia borealis* and gave the additional distributional records from New York and Pennsylvania. It should be noted that this species has been found chiefly in the Upper Austral and Transition Zones.

Length.—6.5 to 10 mm.

Records.—Poughkeepsie. June to the middle of August. Figure 7.

Type.—University of Michigan Museum.

Sarcofahrtia Parker

1916. Parker, Psyche, vol. 23, p. 131.

1916. Aldrich (*Thelodiscus*), *Sarcophaga* and Allies, p. 63, 302.

The genus, *Sarcofahrtia,* was described in detail by Parker (1916). Later in the same year Aldrich (1916) redescribed the genus as *Thelodiscus* and then on page 302 of his "*Sarcophaga* and Allies" pointed out the synonym. Parker (1919) added three new species to the genus.

It is apparent that the genera, *Sarcofahrtia* and *Wohlfahrtia,* are closely related. Both genera have the fifth sternite of the male undivided, epaulets yellow or brownish, vestiture or back of head black, the membrane connecting the genital segments to the remainder of the abdomen is unusually short which makes it somewhat more difficult to examine the genitalia of the species in these two genera than in the case of the *Sarcophaga.* Parker (1916) pointed out this relationship.

The habits of the *Sarcofahrtia* are unknown while the *Wohlfahrtia* are parasites of man and animals and often cause human myiasis.

Genotype.—*Sarcofahrtia ravinia* Parker.

Sarcofahrtia ravinia Parker

1916. Parker, Psyche, vol. 23, p. 123.

1916. Aldrich (*Thelodiscus indivisus*), *Sarcophaga* and Allies, p. 64 and p. 302.

1919. Parker, Ent. News, vol. 30, p. 203.

There are numerous records of *S. ravinia* throughout New Jersey, New England states, and Quebec, Canada. Although it

has never been taken in New York it undoubtedly occurs in the state.

Length.—7 to 11 mm.

Type.—Male and female in Mass. Agr. Coll. collection.

Wohlfahrtia B. & B.

1889. Brauer and Bergenstamm, Denkschr. Kais. Akad. Wiss. Wien, vol. 56, p. 123.

1893. Brauer and Bergenstamm, Verh. Zool.-Bot. Ges. Wien, vol. 43, p. 501.

When this genus was erected by Brauer and Bergenstamm insufficient distinguishing characters were listed. As a result the validity of the genus was doubted until Aldrich (1916) stated the generic characters very clearly.

Townsend (1935) pointed out that the maggots were usually deposited on the upper lip of man and entered the nostrils, though at times occurring in the ear and at other times causing dermal myiasis.

Genotype.—*Wohlfahrtia magnifica* Walker.

Wohlfahrtia vigil Walker

1848. Walker, List of Dipterous Insects in British Museum, vol. 4, p. 831.

1895. Coquillett (*Paraphyto chittendeni*), JOUR. N. Y. ENT. SOC., vol. 3, p. 105.

1895. Coquillett (*Paraphyto chittendeni*), U. S. D. A. Ent. Tech. Bull. No. 7, p. 122.

1916. Aldrich, *Sarcophaga* and Allies, p. 29.

The three rows of shining black spots on the abdomen separate this species from all other Sarcophagids found in New York.

Length.—8 to 14 mm.

Records.—Syracuse; Rochester Junction; Ludlowville; Ithaca; Lockport; Williamsville; Utica; Florida. June to August.

This fly has been recorded as a parasite attacking humans by Walker (1920, 1922, 1931), Felt (1924), Gertson (1933), Matheson (1932) and Ford (1936). Shannon (1923) and Johannsen (1926) published accounts of *W. vigil* as a parasite of young rabbits. Kingscote (1932) gave an account of *W. vigil* causing

myiasis in young fox and mink which resulted in considerable loss in Canada.

Walker (1937) gave a careful description of the immature stages of *W. vigil.*

Type.—Male in British Museum.

Hypopelta Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 49.

When Aldrich (1916) described the genus, *Hypopelta,* he fully listed the characters with the exception of the detailed genitalia differences. The hypopygial studies help to show that the genus is entirely distinct from other *Sarcophaginæ.* The fifth sternite has a large raised circular projection on each side of the lower part of the U. The basal apodeme tends to be circular instead of long and narrow as in the *Sarcophaga.* The plate portion of the ninth sternum is much reduced in comparison to its arms which are larger than the average *Sarcophaga.* The anterior clasper is fused for two-thirds of its length with the ninth sternum. This fusion has not been observed in the case of any other *Sarcophaginæ* examined.

Genotype.—*Hypopelta scrofa* Aldrich.

Hypopelta scrofa Aldrich

1916. Aldrich, *Sarcophaga* and Allies, p. 50.

The males of this species can be easily determined by the row of very long bristles on the anterior clasper and one long bristle on the posterior clasper. Both sexes have on each antennæ a very long, thin arista with short plumosity which extends about two thirds its length.

Length.—6 to 8 mm.

Records.—Ithaca; Owego. Figures 1 to 6 inclusive.

Type.—Male and female. Cat. No. 20491, U. S. N. M.

Metoposarcophaga Townsend

1917. Townsend, Proc. Biol. Soc. Wash., vol. 30, p. 46.

1919. Parker, Can. Ent., vol. 51, p. 154.

The external characters for separating *Metoposarcophaga* from related genera were given only briefly by Townsend when the

genus was erected. Aldrich (1916, 1930) placed the genotype, *importuna,* in the genus, *Sarcophaga.* Parker (1919) recognized *Metoposarcophaga,* described two new species, and gave a key to separate the four species placed in the genus.

The study of hypopygial structures helps to show that the genus is valid. It is unfortunate that *M. importuna* was the only species of *Metoposarcophaga* available for this study. The V of the fifth sternum, which is U-shaped in the case of *M. importuna,* is much more deeply cut than the average *Sarcophaginæ.* The ninth tergite is very large and gives the abdomen a truncate appearance. The arms of the ninth sternum are fused at the tip and more heavily chitinized than the other *Sarcophaginæ.* The internal portion of the ædeagus curves around and fuses to the arms of the ninth sternum as shown in the illustration of the ninth sternum (Fig. 11). The tip of the ædeagus has a distinct brush-like appearance on its front side. The pump sclerite is unusually large, as its diameter is twice the length of the ædeagus, and it has a definite cap on the small end (Fig. 13). All other *Sarcophaginæ* studied have a small pump sclerite when compared with the other hypopygial structures.

Genotype.—*Metoposarcophaga importuna* (Walker).

Metoposarcophaga importuna (Walker)

1848. Walker (*Sarcophaga importuna*), List Dipt. Brit. Museum, vol. 4, p. 819.
1916. Parker (*Sarcophaga pachyprocta*), JOUR. N. Y. ENT. SOC., vol. 24, p. 171.
1916. Aldrich (*Sarcophaga larga, S. pachyprocta*), *Sarcophaga* and Allies, p. 147, 302.
1919. Parker (*M. pachyprocta*), Can. Ent., vol. 51, p. 154.
1930. Aldrich (*Sarcophaga importuna*), Proc. U. S. N. M., vol. 78, p. 15.

The large abdomen which appears truncate behind, distinguishes *M. importuna* from all other *Sarcophaginæ* which have been found in New York.

Length.—6 to 10 mm.

Records.—*L.I.*: Babylon; Heckscher State Park; Dix Hills; Long Beach; Sands Point; Oak Island. May to August. Figures 8 to 13 inclusive.

LITERATURE CITED

Aldrich, J. M. 1916. *Sarcophaga* and Allies in North America, vol. I. Thomas Say Foundation, illus.

———. 1924. Notes on some types of American Muscoid Diptera in the collection of the Vienna Natural History Museum. Ann. Ent. Soc. Am., 17: 209–211.

———. 1930. Notes on the types of American two-winged flies of the genus *Sarcophaga* and a few related forms, described by the early authors. Proc. U.S.N.M., vol. 78, art. 12, no. 2855, pp. 1–43, illus.

Allen, H. W. 1926. North American species of the two-winged flies belonging to the tribe Miltogrammini. Proc. U.S.N.M., vol. 68, pp. 1–106, illus.

Coquillett, D. W. 1897. Revision of the Tachinidæ of North America. U.S.D.A. Tech. Ser. No. 7.

Curran, C. H. 1934. North American Diptera. The Ballou Press, New York, p. 1–512, illus.

Felt, E. P. 1924. *Wohlfahrtia vigil* Walker attacking man. Jour. Econ. Ent., 17: 603.

Ford, N. 1936. Further observations on the behavior of *Wohlfahrtia vigil* (Walker) with notes on the collecting and rearing of the flies. Jour. Parasit., 22: 309–328, illus.

Frison, T. H. 1926. Contribution to the knowledge of the interrelations of the bumblebees of Illinois with their animate environment. Ann. Ent. Soc. Am., 19: 203–234, illus.

Gertson, G. D., Lancaster W. E. B., Larson, G. A. and Wheeler, G. C. 1933. Report of two cases of *Wohlfahrtia* myiasis in North Dakota. Jour. Am. Med. Ass., no. 7, pp. 487–488.

Hall, D. G. 1928. *Sarcophaga pollinervis* and related species in the Americas. Ann. Ent. Soc. Am., 21: 331–352, illus.

———. 1933. The Sarcophaginæ of Panama. Bull. Am. Mus. Nat. Hist., 66: 251–285, illus.

Hallock, H. C. 1929. Notes on methods of rearing Sarcophaginæ and the biology of *Sarcophaga latisterna* Parker. Ann. Ent. Soc. Am., 22: 246–250, illus.

———. 1937. A list of the Sarcophagidæ of New York (Diptera). Ent. News, 48: 258–262.

———. 1938. New Sarcophaginæ (Diptera). Proc. Ent. Soc. Wash. 40: 95–99, illus.

Hardy, G. H. 1927. Notes on Australian and exotic Sarcophagid flies. Proc. Linn. Soc. N. S. Wales, 52: 447–459, illus.

Johannsen, O. A. 1926. *Wohlfahrtia vigil* a parasite upon rabbits. Jour. Parasit., 13: 156.

Kingscote, A. A. 1932. Myiasis in ranch raised foxes. 62nd Ann. Rep. Ent. Soc. Ont., Toronto, pp. 91–93.

Leonard, M. D. 1928. A list of insects of New York. Cornell Univ. Agr. Exp. Sta. Mem. 101, pp. 1–1121.

MATHESON, R. 1932. Medical entomology. Charles C Thomas Press, Baltimore, Md., pp. 1–489, illus.

PARKER, R. R. 1914. Sarcophagidæ of New England. Males of the genera *Ravinia* and *Boettcheria*. Proc. Boston Soc. Nat. Hist., 35: 1–77, illus.

———. 1916 Sarcophagidæ of New England. III. *Sarcofahrtia ravinia*, new genus and new species. Psyche, 23: 123.

———. 1919. North American Sarcophagidæ; New species of the genus *Sarcofahrtia*. Ent. News, 30: 203.

———. 1919. North American Sarcophagidæ: flies of the genus *Metoposarcophaga* Townsend. Can. Ent., 51: 154–158.

PATTON, W. S. 1933. Studies on the higher Diptera of medical and veterinary importance. Ann. Trop. Med. & Parasit., 27: 334–337, illus.

———. 1934. Studies on the higher Diptera of medical and veterinary importance. Ann. Trop. Med. & Parasit., 28: 579–588, illus.

———. 1935. Studies on the higher Diptera of medical and veterinary importance. Ann. Trop. Med. & Parasit., 29: 517–532, illus.

PLATH, O. E. 1922. Notes on the nesting habits of several North American bumblebees. Psyche, 29: 189–202.

———. 1934. Bumblebees and their ways. The Macmillan Company, New York City, pp. 1–201.

REINHARD, H. J. 1929. Notes on the Muscoid flies of the genera *Opelousia* and *Opsodexia* with descriptions of three new species. Proc. U.S.N.M., vol. 76, art. 20.

———. 1937. New North American Muscoid Diptera. Bull. Ent. Soc. Brooklyn, 32: 62–74.

SENIOR-WHITE, R. 1924. A revision of the sub-family *Sarcophaginæ* in the Oriental region. Rec. Indian Museum, 26: 193–284, illus.

SHANNON, R. C. 1923. Non-human host records of *Wohlfahrtia vigil* (Diptera). Proc. Ent. Soc. Wash., 25: 142.

SMITH, C. N. 1933. Notes on the life history and molting processes of *Sarcophaga securifera*. Proc. Ent. Soc. Wash., 35: 159–164.

SNODGRASS, R. E. 1935. Principles of insect morphology. McGraw-Hill Book Company, New York City, pp. 1–667, illus.

TOWNSEND, C. H. T. 1915. Proposal of new Muscoid genera for old species. Proc. Biol. Soc. Wash., 28: 19–23.

———. 1918. Some Muscoid synonymy, with one new genus. Proc. Ent. Soc. Wash., 20: 19–21.

———. 1931. Notes on Old-world Oestromuscoid types. Part I. Ann. and Mag. of Nat. Hist., 8 (10th ser.): 369–391.

———. 1935. Manual of Myiology, Part II. Charles Townsend & Filhos Press, Itaquaquecetuba, São Paulo, Brasil, pp. 1–296, illus.

TOWNSEND, L. H. 1936. The mature larva and puparium of *Brachycoma sarcophagina* (Town.). Proc. Ent. Soc. Wash., 38: 92–98, illus.

WALKER, E. M. 1920. *Wohlfahrtia vigil* (Walker) as a human parasite. Jour. Parasit., 7: 1–7, illus.

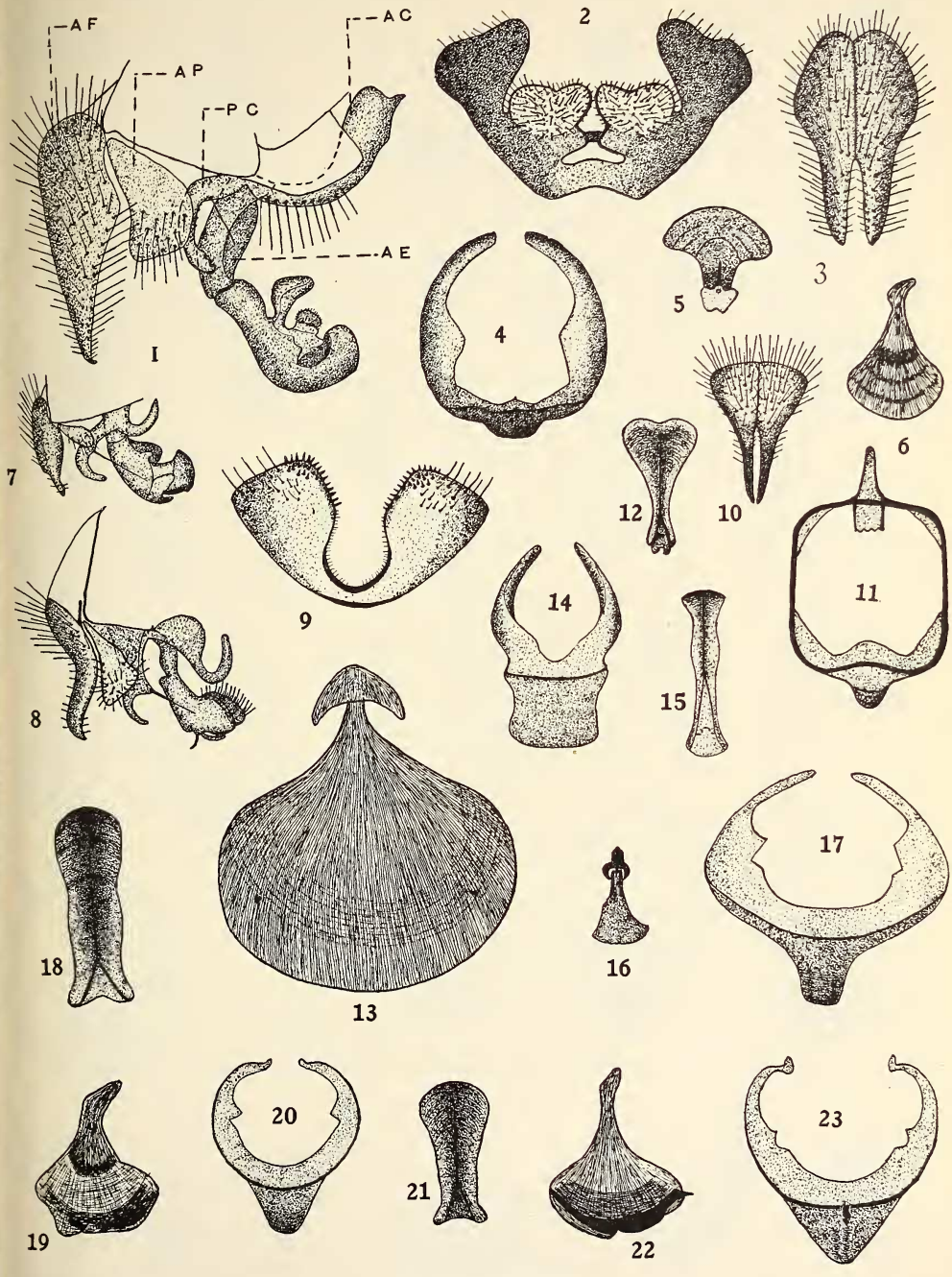
———. 1922. Some cases of cutaneous myiasis, with notes on the larvæ of *Wohlfahrtia vigil* (Walker). Jour. Parasit., 9: 1–5, illus.

———. 1931. Cutaneous myiasis in Canada. Can. Pub. Health, pp. 504–508, illus.

———. 1937. The larval stages of *Wohlfahrtia vigil* (Walker). Jour. Parasit., 23: 163–174, illus.

PLATE II

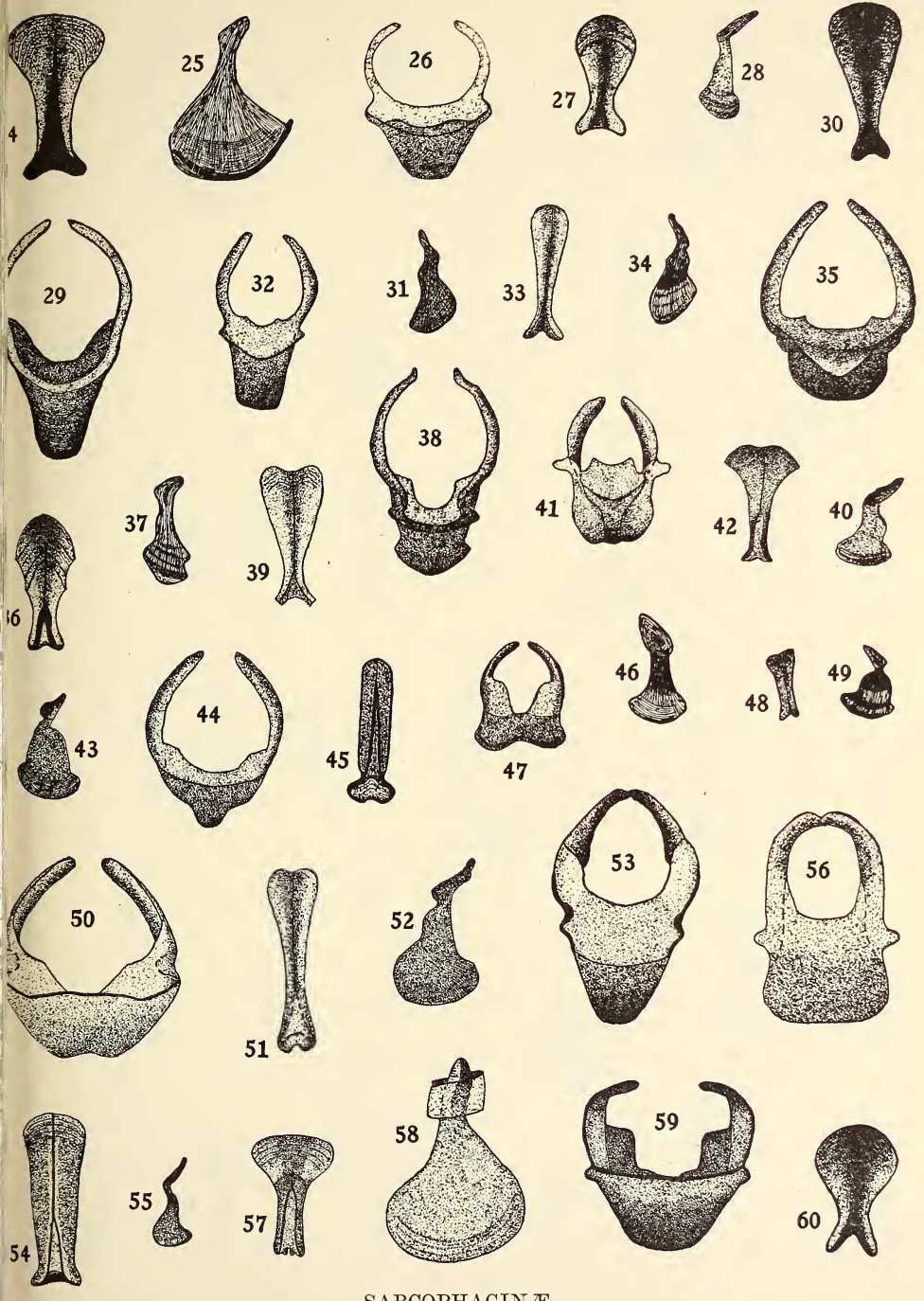
Figure 1. Lateral view of external genitalia of *Hypopelta scrofa.*
Figure 2. Fifth sternum of *Hypopelta scrofa.*
Figure 3. Rear view of anal forceps of *Hypopelta scrofa.*
Figure 4. Ninth sternum of *Hypopelta scrofa.*
Figure 5. Basal apodeme of *Hypopelta scrofa.*
Figure 6. Pump sclerite of *Hypopelta scrofa.*
Figure 7. Lateral view of external genitalia of *Johnsonia borealis.*
Figure 8. Lateral view of external genitalia of *Metoposarcophaga importuna.*
Figure 9. Fifth sternum of *Metoposarcophaga importuna.*
Figure 10. Rear view of anal forceps of *Metoposarcophaga importuna.*
Figure 11. Ninth sternum of *Metoposarcophaga importuna.*
Figure 12. Basal apodeme of *Metoposarcophaga importuna.*
Figure 13. Pump sclerite of *Metoposarcophaga importuna.*
Figure 14. Ninth sternum of *Sarcophaga misera* var. *sarracenioides.*
Figure 15. Basal apodeme of *Sarcophaga misera* var. *sarracenioides.*
Figure 16. Pump sclerite of *Sarcophaga misera* var. *sarracenioides.*
Figure 17. Ninth sternum of *Sarcophaga bisetosa.*
Figure 18. Basal apodeme of *Sarcophaga bisetosa.*
Figure 19. Pump sclerite of *Sarcophaga bisetosa.*
Figure 20. Ninth sternum of *Sarcophaga cimbicis.*
Figure 21. Basal apodeme of *Sarcophaga cimbicis.*
Figure 22. Pump sclerite of *Sarcophaga cimbicis.*
Figure 23. Ninth sternum of *Sarcophaga latisterna.*



SARCOPHAGINÆ

PLATE III

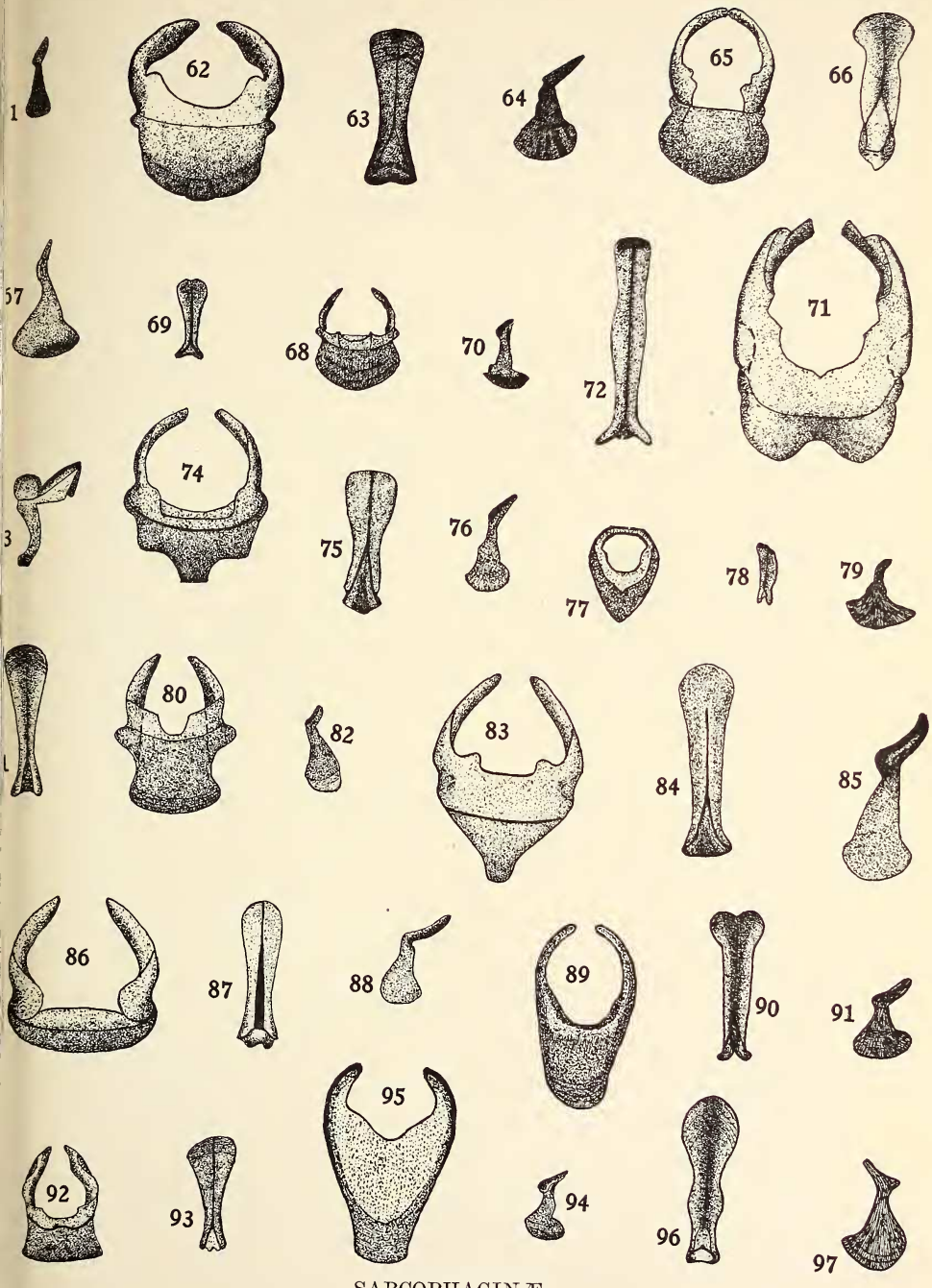
Figure 24. Basal apodeme of *Sarcophaga latisterna.*
Figure 25. Pump sclerite of *Sarcophaga latisterna.*
Figure 26. Ninth sternum of *Sarcophaga latisetosa.*
Figure 27. Basal apodeme of *Sarcophaga latisetosa.*
Figure 28. Pump sclerite of *Sarcophaga latisetosa.*
Figure 29. Ninth sternum of *Sarcophaga l'herminieri.*
Figure 30. Basal apodeme of *Sarcophaga l'herminieri.*
Figure 31. Pump sclerite of *Sarcophaga l'herminieri.*
Figure 32. Ninth sternum of *Sarcophaga pusiola.*
Figure 33. Basal apodeme of *Sarcophaga pusiola.*
Figure 34. Pump sclerite of *Sarcophaga pusiola.*
Figure 35. Ninth sternum of *Sarcophaga stimulans.*
Figure 36. Basal apodeme of *Sarcophaga stimulans.*
Figure 37. Pump sclerite of *Sarcophaga stimulans.*
Figure 38. Ninth sternum of *Sarcophaga sueta.*
Figure 39. Basal apodeme of *Sarcophaga sueta.*
Figure 40. Pump sclerite of *Sarcophaga sueta.*
Figure 41. Ninth sternum of *Sarcophaga alcedo.*
Figure 42. Basal apodeme of *Sarcophaga alcedo.*
Figure 43. Pump sclerite of *Sarcophaga alcedo.*
Figure 44. Ninth sternum of *Sarcophaga aldrichi.*
Figure 45. Basal apodeme of *Sarcophaga aldrichi.*
Figure 46. Pump sclerite of *Sarcophaga aldrichi.*
Figure 47. Ninth sternum of *Sarcophaga atlanis.*
Figure 48. Basal apodeme of *Sarcophaga atlanis.*
Figure 49. Pump sclerite of *Sarcophaga atlanis.*
Figure 50. Ninth sternum of *Sarcophaga barbata.*
Figure 51. Basal apodeme of *Sarcophaga barbata.*
Figure 52. Pump sclerite of *Sarcophaga barbata.*
Figure 53. Ninth sternum of *Sarcophaga bullata.*
Figure 54. Basal apodeme of *Sarcophaga bullata.*
Figure 55. Pump sclerite of *Sarcophaga bullata.*
Figure 56. Ninth sternum of *Sarcophaga flavipalpis.*
Figure 57. Basal apodeme of *Sarcophaga flavipalpis.*
Figure 58. Pump sclerite of *Sarcophaga flavipalpis.*
Figure 59. Ninth sternum of *Sarcophaga fletcheri.*
Figure 60. Basal apodeme of *Sarcophaga fletcheri.*



SARCOPHAGINÆ

PLATE IV

Figure 61. Pump sclerite of *Sarcophaga fletcheri.*
Figure 62. Ninth sternum of *Sarcophaga hæmorrhoidalis.*
Figure 63. Basal apodeme of *Sarcophaga hæmorrhoidalis.*
Figure 64. Pump sclerite of *Sarcophaga hæmorrhoidalis.*
Figure 65. Ninth sternum of *Sarcophaga houghi.*
Figure 66. Basal apodeme of *Sarcophaga houghi.*
Figure 67. Pump sclerite of *Sarcophaga houghi.*
Figure 68. Ninth sternum of *Sarcophaga hunteri.*
Figure 69. Basal apodeme of *Sarcophaga hunteri.*
Figure 70. Pump sclerite of *Sarcophaga hunteri.*
Figure 71. Ninth sternum of *Sarcophaga johnsoni.*
Figure 72. Basal apodeme of *Sarcophaga johnsoni.*
Figure 73. Pump sclerite of *Sarcophaga johnsoni.*
Figure 74. Ninth sternum of *Sarcophaga parallela.*
Figure 75. Basal apodeme of *Sarcophaga parallela.*
Figure 76. Pump sclerite of *Sarcophaga parallela.*
Figure 77. Ninth sternum of *Sarcophaga rapax.*
Figure 78. Basal apodeme of *Sarcophaga rapax.*
Figure 79. Pump sclerite of *Sarcophaga rapax.*
Figure 80. Ninth sternum of *Sarcophaga reversa.*
Figure 81. Basal apodeme of *Sarcophaga reversa.*
Figure 82. Pump sclerite of *Sarcophaga reversa.*
Figure 83. Ninth sternum of *Sarcophaga scoparia* var. *nearctica.*
Figure 84. Basal apodeme of *Sarcophaga scoparia* var. *nearctica.*
Figure 85. Pump sclerite of *Sarcophaga scoparia* var. *nearctica.*
Figure 86. Ninth sternum of *Sarcophaga securifera.*
Figure 87. Basal apodeme of *Sarcophaga securifera.*
Figure 88. Pump sclerite of *Sarcophaga securifera.*
Figure 89. Ninth sternum of *Sarcophaga sinuata.*
Figure 90. Basal apodeme of *Sarcophaga sinuata.*
Figure 91. Pump sclerite of *Sarcophaga sinuata.*
Figure 92. Ninth sternum of *Sarcophaga uncata.*
Figure 93. Basal apodeme of *Sarcophaga uncata.*
Figure 94. Pump sclerite of *Sarcophaga uncata.*
Figure 95. Ninth sternum of *Sarcophaga ventricosa.*
Figure 96. Basal apodeme of *Sarcophaga ventricosa.*
Figure 97. Pump sclerite of *Sarcophaga ventricosa.*



SARCOPHAGINÆ